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DOCUMENT-IDENTIFIER: US 6269099 B1
TITLE: Protocol and method for peer network device discovery

Brief Summary Text (14):
One aspect of a peer discovery method for a preferred embodiment of the present
invention includes receiving an original first data packet from a first network
device (e.g., a host network device) on a second network device (e.g., an edge
router) on a first network. The first data packet (e.g., TCP/IP) is used to
establish a connection from the first network device on the first network to a
fourth network device on a second network (e.g., a host network device to another
host network device). A peer discovery marker from a peer discovery protocol is
added to a header in the first data packet on the second network device to create a
modified first data packet as the packet passes through the second network device.
The peer discovery marker includes a network address for the second network device
that is trying to discover a peer network device. In a preferred embodiment of the
present invention, the peer discovery marker is added as an additional networking
option to a networking protocol such as TCP. The modified first data packet is sent
from the second network device on the first network to a third network device on
the second network via the third network (e.g., the Internet).

Brief Summary Text (16):
Another aspect of the peer discovery method for a preferred embodiment for the
present invention includes creating a second data packet on the third network
device to establish a two-way peer-to-peer data flow to the peer second network
device. The second data packet is created after the third network device receives a
modified first data packet with a peer discovery marker. The second data packet can
be a TCP, User Datagram Protocol ("UDP") or other networking protocol data packet.
As is known in the art, UDP provides a connectionless mode of communications with
datagrams in an interconnected set of networks. The third network device adds its
own network address and the network address of its associated host network device
to the second data packet (e.g., IP addresses). The third network device sends the
second data packet to the peer second network device via the third network (e.g.,
the Internet).

Drawing Description Text (3):
FIG. 1 is a block diagram illustrating a network system for peer network address
discovery;

Detailed Description Text (6):
The memory system may include main memory and secondary storage. The main memory is
high-speed random access memory ("RAM"). Main memory can include any additional or
alternative high-speed memory device or memory circuitry. Secondary storage takes
the form of long term storage, such as Read Only Memory ("ROM"), optical or
magnetic disks, organic memory or any other volatile or non-volatile mass storage
system. Those skilled in the art will recognize that the memory system can comprise
a variety and/or combination of alternative components.

Detailed Description Text (7):
It will be appreciated that the acts and symbolically represented operations
include the manipulation of electrical signals by the CPU. The electrical signals

cause transformation of data bits. The maintenance of data bits at memory locations
in a memory system thereby reconfigures or otherwise alters the CPU's operation.
The memory locations where data bits are maintained are physical locations that
have particular electrical, magnetic, optical, or organic properties corresponding
to the data bits.

Detailed Description Text (8):
The data bits may also be maintained on a computer readable medium including
magnetic disks, optical disks, organic disks and any other volatile or non-volatile
mass storage system readable by the CPU. The computer readable medium includes
cooperating or interconnected computer readable medium, which exist exclusively on
the processing system or may be distributed among multiple interconnected
processing systems that may be local or remote to the processing system.

Detailed Description Text (13):
Above network layer 30 is a transport layer 36. Transport layer 36 includes a
Transmission Control Protocol ("TCP") layer 38 and a User Datagram Protocol ("UDP")
layer 40. TCP layer 38, hereinafter TCP 38, provides a connection-oriented, end-to-
end reliable protocol designed to fit into a layered hierarchy of protocols which
support multi-network applications. TCP 38 provides for reliable inter-process
communication between pairs of processes in network devices attached to distinct
but interconnected networks. For more information on TCP 38 see RFC-793,
incorporated herein by reference.

Detailed Description Text (14):
UDP layer 40, hereinafter UDP 40, provides a connectionless mode of communications
with datagrams in an interconnected set of computer networks. UDP 40 provides a
transaction-oriented datagram protocol, where delivery and duplicate packet
protection are not guaranteed. For more information on UDP 40 see RFC-768,
incorporated herein by reference. Both TCP 38 and UDP 40 are not both required in
protocol stack 26.

Detailed Description Text (17):
FIGS. 3A and 3B are block diagrams illustrating components of a peer discovery
protocol 44. However, more or fewer peer discovery protocol components could also
be used. As is illustrated in FIG. 3A, peer discovery protocol 44 includes a peer
discovery marker 46. Peer discovery marker includes a kind-field 48, a length-field
50 and a network address-field 52. However, more or fewer fields could also be used
in peer discovery marker 46. In a preferred embodiment of the present invention,
peer discovery marker 46 includes a 1-byte kind-field 48 containing a unique number
(e.g., 128). Length-field 50 is a 1-byte field indicating a length of the marker in
bytes (e.g., 6 bytes). Network address-field 52 is a 4-byte field containing a
network address (e.g., IP address) of a network device that wishes to be
discovered. However, other field sizes and values could also be used and the
present invention is not limited to the field sizes and values described.

Detailed Description Text (20):
For two network devices to establish a connection with TCP 38, a TCP 38 three-way
handshake is used. FIGS. 4A, 4B and 4C are block diagrams illustrating TCP/IP
three-way handshake segments 62. As an example, first network device 14 desires to
establish a TCP 38 connection with fourth network device 22. First network device
14 transmits a TCP 38 segment with a SYnchronize sequence Numbers ("SYN") flag set,
called a "TCP 38 SYN segment" to fourth network device 22 using IP 32. FIG. 4A
illustrates an exemplary TCP/IP SYN segment 64 sent from first network device 14 to
fourth network device 22. TCP/IP SYN segment 64 typically contains a TCP 38 Option
for advertising a Maximum Segment Size ("MSS") that the network device can accept.
TCP 38 allows multiple configuration Options to be set. For more information on TCP
38 Options see RFC-793. TCP/IP SYN segment 64 illustrates an exemplary IP 32
address for first network device 14 of 128.10.20.31 as source IP 32 address and an
IP 32 address for fourth network device 22 of 110.11.12.15 as destination IP 32

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address. TCP/IP SYN segment 64 includes other fields that are normally set in the segments illustrated in FIG. 4. However, such fields (e.g., TCP 38 header length, TCP 38 checksum, IP 32 total length) are not illustrated in FIG. 4. For more information on such fields see RFC-793.

Detailed Description Text (25):
As was illustrated above, first network device 14 on first network 12 typically initiates a TCP 38 connection to fourth network device 22 on second network 18 via third network 24. It is desirable to allow second network device 16 functioning as an "edge router" to discover a network address of its peer edge router (e.g., third network device 20) as the TCP 38 connection between host network devices first network device 14 and fourth network device 22 is being established. Once the edge routers have discovered each other, they can establish a two-way peer-to-peer "data flow" (i.e., another TCP 38 channel or a UDP 40 channel) between themselves and transmit information such as "intelligent" routing capabilities, requests, or commands and other information. Peer discovery is accomplished using peer discover protocol 44.

Detailed Description Text (27):
At step 74, peer discovery marker 46 from peer discovery protocol 44 is added to a header in the original first data packet on second network device 16 to create a modified first data packet. Peer discovery marker 46 includes a network address for second network device 16 (e.g., IP 32 address 128.10.20.30).

Detailed Description Text (30):
In a preferred embodiment of the present invention, first network device 14 (FIG. 1) transmits a TCP/IP SYN segment 64 (FIG. 4A) intended for fourth network device 22 (FIG. 1) to establish a TCP 38 connection. As TCP/IP SYN segment 64 passes through second network device 16 (i.e., a first edge router), second network device 16 puts its own IP 32 address (e.g., 128.10.20.30) in network address-field 52 (FIG. 3A) of peer discovery marker 46. Kind-field 48 is set to 128 and length-field 50 is set to six, since the peer discovery marker is 6-bytes long.

Detailed Description Text (33):
FIG. 7 is a flow diagram illustrating a method 82 for peer network device discovery. At step 84, a modified first data packet (e.g., a TCP/IP packet with a peer discovery marker 46 in a TCP 38 header) is received on third network device 20 (i.e., a second edge router) on second network 18 via the third network 24. At step 86, information from the peer discovery marker in 46 the modified first data packet is extracted and stored in a first peer discovery table on the third network device 20 (e.g., the network address of second network device 16). At step 88, peer discovery marker 46 is deleted from the header in the peer discovery data packet by third network device 20 to recover an original first data packet (e.g., TCP/IP SYN segment 64). At step 90, the original first data packet is sent to fourth network device 22.

Detailed Description Text (34):
In a preferred embodiment of the present invention, third network device 20 (i.e., second edge router) removes peer discovery marker 46 from TCP 38 header. The network address for the peer network device (e.(g., second network device 16) from peer discover marker 46 is stored in a peer discovery table along with the network address for the host network device associated with the peer network device from the IP 32 header (e.g., from the IP 32 source field).

Detailed Description Text (35):
FIGS. 8A and 8B are block diagrams illustrating exemplary peer discovery tables. FIG. 8A is a block diagram illustrating an exemplary peer discovery table 92 for peer third network device 20 created as a result of execution of methods 70 (FIG. 5) and 82 (FIG. 7). Peer discovery table 86 (FIG. 8A) includes a network address (i.e., an IP 32 address 128.10.20.30) for a peer network device, which is second

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network device 16, and a network address for its associated host network device,
first network device 14 (i.e., 128.10.20.31).

Detailed Description Text (38):
At step 104, third network device 20 adds its network address (e.g., IP 32 address
110.11.12.14) and a network address (e.g., IP 32 address 110.11.12.15) for an
associated host network device to the second data packet.

Detailed Description Text (40):
FIG. 10 is a flow diagram illustrating a method 108 for peer network device
discovery. At step 110, a second data packet is received on second network device
16 on first network 12 via the third network 24 from third network device 20. At
step 112, network address information for a peer network device and its associated
peer host network device is extracted from the second data packet. At step 114, the
network address information extracted from second data packet is stored in a peer
discovery table (e.g., peer discovery table 96 of FIG. 8B) on second network device
16. Peer discovery table 96 (FIG. 8B) includes a network address (e.g., an IP 32
address) for a peer network device, which is third network device 20, and a network
address for its associated host, fourth network device 22. Peer discovery table 96
includes an exemplary table entry 98 illustrating an network address (i.e., IP 32
address 10.11.12.14) for peer third network device 20 and its associated host,
fourth network device 22 (i.e., IP 32 address 110.11.12.15).

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CLAIMS:

1. In a first network with a plurality of network devices connected to a second
network with a plurality of network devices via a third network, a method of peer
network device discovery, the method comprising the following steps:

receiving an original first data packet from a first network device on a second
network device on the first network, wherein the first data packet is used to
establish a connection from the first network device on the first network to a
fourth network device on the second network;

adding a peer discovery marker from a peer discovery protocol to a header in the
first data packet on the second network device to create a modified first data
packet, wherein the peer discovery marker includes a network address for the second
network device; and

sending the modified first data packet from the second network device on the first
network to a third network device on the second network via the third network.

3. The method of claim 2 further comprising:

creating a second data packet on the third network device after receiving the
modified first data packet;

adding a first network address for the third network device and a second network
address for an associated host fourth network device to the second data packet; and

sending the second data packet from the third network device on the second network
to the second network device on the first network via the third network, thereby
providing information for establishing a two-way peer-to-peer data flow between the
third network device and the second network device.

4. The method of claim 3 further comprising:

receiving the second data packet on the second network device on the first network
via the third network;

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extracting a first network address for the peer third network device and a second network address for the for the associated host fourth network device from the second data packet; and

storing the first network address and the second network address in a second peer discovery table from a peer discovery protocol on the second network device, thereby providing network addresses for establishing a two-way peer-to-peer data flow between the second network device and the third network device via the third network.

7. The method of claim 1 wherein the peer discovery marker includes a kind-field, a length-field and a network address-field for a Transmission Control Protocol Option.

13. The method of claim 2 wherein the first peer discovery table includes a first network address-field for storing a first network address for a peer network device and a second network address-field for storing a second network address for an associated host network device for the peer network device.

17. In a first network with a plurality of network devices connected to a second network with a plurality of network devices via a third network, a method of peer network device discovery, the method comprising the following steps:

receiving a second data packet on a first network device on the first network, wherein the second data packet is sent by a second network device on a second network in response to a first data packet including a peer discovery marker from a peer discovery protocol sent by the first network device;

extracting a first network address for the second network device and a second network address for a host network device associated with the second network device from the second data packet; and

storing the first network address and the second network address in a peer discovery table from a peer discovery protocol on the first network device, thereby providing network addresses for establishing a two-way peer-to-peer data flow between the first network device and the second network device.

20. The computer readable medium of claim 19 wherein the peer discovery marker includes a kind-field, a length-field and a network address-field for a Transmission Control Protocol Option.

21. The computer readable medium of claim 19 wherein the peer discovery table includes a first network address-field for a peer network device and a second network address-field for an associated host network device for the peer network device.

24. In a first network with a plurality of network devices connected to a second network with a plurality of network devices via a third network, the network devices including a plurality of edge routers, a method of peer network device discovery, the method comprising the following steps:

adding a peer discovery marker from a peer discovery protocol to a header in a first data packet on a first edge router to create a modified first data packet, wherein the peer discovery marker includes a first network address for the first edge router;

sending the peer discovery data packet from the first edge router on the first network to a second edge router on the second network via the third network;

receiving a second data packet on the first edge router, wherein the second data

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packet is sent by the second edge router on a second network in response to the modified first data packet;

extracting a second network address for the second edge router from the peer discovery marker and a third network address for a host network device associated with the second edge router from the second data packet; and

storing the second network address and the third network address in a peer discovery table from a peer discovery protocol on the first edge router, thereby providing network addresses for establishing a two-way peer-to-peer data flow between the first edge router and the second edge router.

27. In a first network with a plurality of network devices connected to a second network with a plurality of network devices via a third network, the network devices including a plurality of edge routers, a method of peer network device discovery, the method comprising the following steps:

receiving a modified first data packet with a peer discovery protocol marker on a first edge router on the first network from a second edge router on the second network;

extracting a first network address for the second edge router from the peer discovery protocol marker and a second network address for a host network device associated with the second edge router from the modified first data packet;

storing the first network address for the second edge router from the peer discovery marker and the second network address from the modified first data packet in a peer discovery table from the peer discovery protocol on the first edge router;

creating a second data packet on the first edge router in response to the modified first data packet;

adding a third network address for the first edge router and a fourth network address for host network device associated with the first edge router to the second data packet;

sending the second data packet from first edge router on the first network to the second edge router on the second network via the third network, thereby providing network addresses for establishing a two-way peer-to-peer data-flow between the first edge router and the second edge router via the third network.